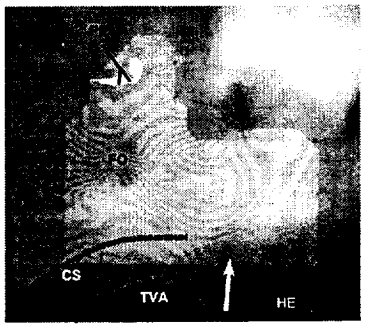
ode array and a bipolar His electrogram (HE) were used to record conduction patterns in a rabbit AV node preparation superfused at 36°C. The right atrial septum superior to the foramen ovalis (FO) was electrically paced via a bipolar electrode (PE) at a constant interval of 400 ms. The tissue was stained with a 2 mM solution of di-4-ANEPPS optically active dye for 20 minutes. The isochronal activation patterns were constructed by linear interpolation of times in the image space between photodiode elements (effective distance 625 μm on center). Light and dark banding represent 1 ms isochrones.

Results: This preparation demonstrated a normal atrio-Hisian (AH) interval of 56 ms. An isochronal map of one such impulse is shown in the figure. With steady-state pacing, the pattern of activation above the compact node (arrow) was always similar from impulse to impulse. Pattern variation was most apparent at the compact node and below. Slow conduction as indicated by the narrow isochrones was confined to the compact node and subordinate fibers immediately above the tricuspid valve annulus (TVA). The broadening of the isochrones in the lower right-hand corner of the preparation indicates the faster conduction velocities of the His-Purkinje system beneath the HE. The width and breadth of the slow conduction band had the greatest variation with beat-to-beat changes in AH interval.

Conclusion: Optical recordings with linear interpolation have the potential for resolving the heterogenous conduction velocities in the AV node and producing meaningful single conduction patterns. This technique should be useful in describing AV node conduction patterns under a variety of conditions.



1009-50 Pseudo Atrioventricular and Ventriculoatrial Block Induced by Radiofrequency Ablation of Several Atrio-AV Nodal Connections

Kenichiro Otomo, Benjamin J. Scherlag, Warren M. Jackman, Ralph Lazzara. *University of Oklahoma Health Sciences Center and Dept. of Veterans Affairs Medical Center, Oklahoma City, OK*

We determined the roles of the various atrial(A)-atrioventricular nodal (AVN) connections in AV and VA conduction by sequential radiofrequency (RF) ablation. In prior studies, RF ablation applied epicardially to the "fast" pathway (FP) induced A-His bundle (Hb) area delay $\geq$40 msec and the shift of retrograde A activation from the Hb area to the area of the coronary sinus (CS) ostium, "slow" pathway (SP). Subsequent SP ablation significantly increased the A-H interval, $\geq$70 msec, and caused VA block in >50%. Histology showed an intact AVN and ablation of its posterior input. In this study, 6 dogs, FP and SP were ablated by the same epicardial approach. Complete AV and VA block were observed in only 1 of 6 dogs. In another 9 dogs, a third lesion was placed endocardially from the fossa ovalis to the entrance of the inferior vena cava, in addition to FP and SP ablation, causing complete AV and VA block in 5 of 9 dogs. During block, a stable AV junctional escape rate (58 $\pm$ 10/min) appeared, indicating a supra-hisian pacemaker. In 1 case of "AV block", pacing from the A close to the Hb showed 1:1 A-Hb-V conduction up to a rate of 200/min. In addition, there was 1:1 retrograde conduction to the high right (HR) A with marked conduction delay. In 2 other cases, there was 1:1 V-HbA conduction during RV pacing, but HRA and CSA electrograms were dissociated. Postmortem, the AV junction showed that all radiofrequency lesions bordered the triangle of Koch. We conclude that there are multiple atrio-AVN connections which provide back-up mechanisms to prevent combined AV and VA block in the normal heart. Moreover, ablation of two or more A inputs can result in pseudo AV and VA block, since some A remains connected to a functional AVN and Hb.

1010 Importance of Gender and Type of Stress

Wednesday, March 22, 1995, Noon–2:00 p.m.
Ernest N. Morial Convention Center, Hall E
Presentation Hour: Noon–1:00 p.m.

1010-61 Influence of Gender on the Diagnosis of Coronary Artery Disease Using Exercise Thallium-201 SPECT

M. John Williams, Thomas H. Marwick, Michael S. Lauer, Claire Snader, Sebastian A. Cook, Fredric Pashkow, James D. Thomas. *Cleveland Clinic, Cleveland, OH*

Previous studies of Tl-201 SPECT for the diagnosis of coronary artery disease (CAD) have not examined the influence of gender on the accuracy of the test. We examined the results of Tl-201 in 567 pts (403 men, 164 women) who underwent exercise Tl-201 SPECT and coronary angiography.

All pts exercised maximally, with Tl-201 injection 1 min prior to the completion of exercise. SPECT was obtained using a 2- or 3-headed camera, obtaining images within 10 minutes of stress and 4 h later. Using a 24 segment model, perfusion defects were identified by the reduction of regional activity >20% below maximal (>30% in inferior and posterior segments); reversibility was identified by >15% increase of counts in the redistribution image. Two-dimensional echocardiograms were available in 163 pts (including 83 women), with measurements of left ventricular (LV) dimensions and calculation of LV mass using the Penn convention. Significant CAD (n = 324) was defined by stenoses >50% in the left main, >70% in the main coronary vessels; 172 had multivessel (MVD) and 152 had single vessel disease (SVD), with more SVD in women (55% vs 44%, p = NS). The overall sensitivity of exercise Tl-201 SPEGT was 74%. The specificity in the 243 pts without CAD was 50% (41% in men, 67% in women), reflecting referral bias to angiography. Among 244 men with CAD, the sensitivity was 79%, compared with 61% in 80 women ($p < 0.002$). The sensitivity for MVD was 86% in men and women (p = NS). SVD was present in 108 men and 44 women, among whom the sensitivities were 83% and 59% respectively ($p < 0.0001$).

In order to further evaluate the causes of lower exercise Tl-201 sensitivity in women, a subgroup of 83 with echocardiographic data were analyzed. Pts with true positive (n = 26) and false negative (n = 18) results demonstrated a similar hemodynamic response to stress, workload, and LV dimensions. Pts with false negative findings had a higher prevalence of single vessel disease (89% vs 23%, $p < 0.0001$), and technically difficult studies (39% vs 4%, p = 0.01).

Conclusion: Exercise Tl-201 SPECT is effective for the diagnosis of MVD in women, but is less sensitive for the detection of SVD than in men. The lower sensitivity of Tl-201 in women does not appear to be explained on the basis of LV dimensions or exercise capacity.

1010-62 Impact of Breast Repositioning in Women on SPECT Thallium-201 Myocardial Perfusion Imaging

John Fox, Prateek Dalal, Evangeline Luna, Carolyn Klepser, Andrew Van Tosh, Roberto Roberti, Jennifer Pompliano, Steven F. Horowitz. *Beth Israel Medical Center, New York, NY*

Breast attenuation (BA) is recognized as a cause of artifactual anterior perfusion abnormalities on SPECT thallium imaging (Tl) in women. To study the effect of BA on *all* myocardial regions, we used the change in apparent regional perfusion caused by left breast repositioning as an index of BA. Tl was performed on 432 women and 2 redistribution images were acquired: R1 (breast neutral position) and R2 (breast repositioned to upper left). In 11 control pts the R2 image was performed without repositioning. For each pt, 2 separate polar maps were constructed from R1 and R2 short axis slices and were divided into lateral, inferior, septal, anterior, and apical sectors. Mean normalized counts per pixel (MNC) were determined for each sector. The change in apparent perfusion due to breast repositioning for a given sector was computed as (MNC in R2) — (MNC in R1) and was determined for each sector in all pts. The change in apparent perfusion occurring in a sector due to intrastudy variability was determined as the 95% confidence limits of (MNC in R2) — (MNC in R1) for that sector in the control subjects. A significant change in apparent perfusion in a sector due to breast repositioning was defined as one which exceeds the 95% confidence limits for intrastudy variability for that sector.

Results: Breast repositioning caused a significant change in apparent perfusion in 91% of patients in *at least one sector*. The number of pts showing a change in apparent perfusion in *each sector* is shown:

n = 432 pts	lat	inf	sep	ant	apex
decreased perfusion	19	73	52	126	10
no change	335	288	295	193	207
increased perfusion	78	71	85	113	215

Conclusion: Breast repositioning studies suggest that BA affects SPECT myocardial perfusion imaging in the majority of women. Although the greatest frequency of change in perfusion occurs in the anterior segment, the breast attenuation influences all segments.

1010-63 Sex Related Differences in the Response and Diagnostic Accuracy of Dipyridamole Myocardial Perfusion Scintigraphy

James R. Lucas, Poonam Agarwal, Michael W. Dae, Elias H. Botvinick. *The University of California, San Francisco*

We sought to identify any sex based differences in the symptomatic, hemodynamic, and electrocardiographic response to, and the diagnostic accuracy of, dipyridamole perfusion scintigraphy (DPS). We compared the hemodynamic response and image findings in 391 consecutive patients, 236 males and 155 females, who had DPS and Selective Coronary Angiography within 3 months for clinical indications.

There were no sex related differences in the prevalence of prior myocardial infarction, the frequency, intensity or nature of induced symptoms, blood pressure or electrocardiographic ST changes. On Selective Coronary Angiography, 90% of men and 86% of women had coronary disease (p = NS). Among the 391 patients, there were 162 with triple, 108 with double, and 76 with single vessel disease. There were no sex related differences in coronary disease extent (i.e. 1, 2 or 3 vessel involvement), or stenosis severity (i.e. $70\% < x < 90\%$ or $\geq 90\%$). There were also no sex related differences in the incidence of fixed or reversible scintigraphic defects. In men compared to women, the overall diagnostic sensitivity (93% vs. 92%) and specificity (60% vs. 77%), and per vessel sensitivity (327/474, 69% vs. 214/297, 72%) were not significantly different, nor were sensitivities for single (41/47, 87% vs 25/29, 86%), double (61/66, 92% vs. 38/42, 90%) or triple (96/100, 96% vs. 59/62, 95%) vessel coronary disease. Per vessel specificity was greater for women when compared to men (141/168, 84% vs. 165/234, 71%) $p < 0.05$, as well as circumflex disease sensitivity (58/91, 64% vs. 65/145, 45%) and specificity (59/84, 92% vs. 73/91, 80%) ($p < 0.05$).

These results suggest that there is no sex related differences in dipyridamole induced symptoms or the related hemodynamic or electrocardiographic responses. The mechanism and diagnostic accuracy of DPS in women is equal to or greater than that in men across a broad spectrum of coronary artery disease.

1010-64 Left Ventricular Size Effects the Diagnostic Accuracy of SPECT Thallium-201 Perfusion Imaging in Both Men and Women

Christopher L. Hansen, Betsie Figueroa, Vincent Sorrell. *Temple University Hospital, Philadelphia, PA*

The diagnostic accuracy of SPECT Tl-201 for coronary artery disease (CAD) is lower in women (F) than in men (M). Previous investigators have suggested a Bayesian explanation. More recently, it has been suggested that smaller left ventricular mass in women was the cause. The current study was undertaken to assess the effect of left ventricular size (LVsize) on the accuracy of SPECT Tl-201. For this study patients who had either less than 5% pretest probability of CAD (nls) or had cardiac catheterization performed within 45 days of stress thallium testing without an intervening cardiac event (pts) were identified. We excluded patients with pathologic Q waves, documented prior infarction, LBBB on EKG, prior CABG or non-ischemic cardiomyopathy. We identified a total of 259 subjects (153 M, 106 F). Patients with <50% stenosis on cath were analyzed as nl. Twenty M and 20 F were taken from the nls and processed separately to create normal limits. Images were reconstructed with a Hanning filter. The fraction of the left ventricle less than 1, 2, 2.5, 3 and 4 standard deviations was calculated and used to calculate the area under the receiver operating characteristic (ROC) curves using the Dorfman maximum likelihood technique. A measure of left ventricular size was generated from short axis slice diameter and the number of slices. The number of stenosed vessels (2.0 ± 0.8 vs. 1.9 ± 0.9, p = NS) and worst stenosis ($91 \pm 12\%$ vs. $89 \pm 15\%$, p = NS) were similar for M and F. M exercised to higher workloads (estimated METS 6.7 ± 3.1 vs. 4.3 ± 2.3, $p < 0.0001$) but similar peak heart rates (HR) and percent of maximal predicted HR (133 ± 19 vs. 130 ± 22 and $78 \pm 11\%$ vs. $79 \pm 13\%$, both p = NS). The LVsize was greater in men (105 vs. 79 $p < 0.001$). The area under the ROC curves for M was marginally greater than F (0.92 vs. 0.82 $p = 0.10$). LV size significantly affected accuracy; the ROC area for M and F with LVsize >75 was much greater than for those <75 (0.89 vs. 0.64 $p = 0.007$). There was no significant difference in accuracy between M and F with LVsize >75 (0.91 vs. 0.85, $p = 0.47$). We conclude that a small LVsize significantly reduces the accuracy of SPECT Tl-201 in M and F, but since F have, on average, smaller LVsize, they are more likely to be affected.

1010-65 Predicting Adverse Outcome in a Mixed Population with Exercise SPECT Sestamibi (MIBI) Scans

Tim S. Boyne, Bruce A. Koplan, William Parsons, William H. Smith, Denny D. Watson, George A. Beller. *University of Virginia, Charlottesville, Virginia*

There is widespread use of MIBI for the diagnosis of coronary artery disease (CAD) because of favorable imaging characteristics including better tissue penetration and less attenuation with obesity or breast tissue. There is little data available on the utility of exercise SPECT MIBI in predicting long-term outcome. We sought to determine our ability at predicting adverse events in a typical population with comparable distribution of males and females. In 1992, 255 consecutive patients (126 female) had exercise SPECT MIBI scans for evaluation of chest pain syndrome, CAD, or myocardial infarction (MI). Acquisition of perfusion images was accomplished with a single head Sophy DS7 camera using 32 projections over a 180 degree body contour orbit at 25 seconds/step, and energy window peaked at 140 keV (20% symmetry). A low energy all purpose collimator was used and processing was performed on a Sophy computer. Clinical readings were reviewed and scored by independent observers as normal (NL), or abnormal (AB). Follow-up was performed by written questionnaire, telephone interview, and review of clinic charts. The events, non-fatal MI and cardiac death, were corroborated by chart review or physician contact when possible. Patients (pts) were excluded from analysis if they had revascularization within 1 month of imaging. The follow-up interval was defined as time from scanning until an event, late revascularization, or patient response. Follow-up averaged 18 months and was $\approx$92% complete with no significant difference in response rate or time noted between gender or scan score. In total, there were 172 NL scans (i.e. 67%), and 83 AB scans (33%). Of the 255 pts, 2/172 NL, and 6/83 AB had clinical events. Statistical analysis using the Kaplan-Meier survival curve suggests a significant difference in event free survival between NL and AB scans with AB scans portending worse outcome ($t = 8.0484$, Chi square $p < 0.005$).

Conclusion: exercise SPECT MIBI scans do predict adverse outcome in a typical referral population with a high prevalence of women.

1010-66 Comparison of Supine and Upright SPECT Myocardial Perfusion Imaging

Lynne L. Johnson, E. Lindsey Tauxe, Kristi R. Smith. *University of Alabama at Birmingham, Birmingham, Alabama*

Cardiac tomography can be performed in the upright position using a stationary small FOV multicrystal camera (MCC) and a rotating chair. The chair both rotates and jogs to improve spatial resolution of the MCC. To investigate the diagnostic accuracy of this imaging technique compared to conventional supine SPECT, 25 patients with CAD (23 M, 2 F, mean age = 58 ± 10 years, 11 with prior MI) and 18 subjects with low pretest probability for having disease (9 M, 9 F, mean age 49 ± 11 years) underwent a one day rest/stress, low dose/high dose Tc-99m sestamibi study with sequential supine and upright SPECT imaging performed following rest and stress injections. Mean treadmill time for patients = 7.8 ± 2.1 mins, peak HR = 143 ± 17, and 11 were electrically positive. Mean treadmill time for subjects was 8.9 ± 3.4 mins, peak HR = 166 ± 17. Recent coronary angiography was performed in 17/23 CAD patients with 34 lesions >50%. Each tomogram was divided into 7 segments and each segment scored as normal, reversible, or fixed. The agreement between the 2 sets of scans was 98% and the segment agreement with regard to reversibility was 90%. Supine SPECT detected 21/23 (91%) of patients with CAD, the chair detected 20/23% (87%). The chair detected 18/34 (53%) CA lesions, supine detected 20/34 (59%). Sensitivity and specificity for the chair was 88%, and 100%, and for supine was 92%, and 100%. In conclusion, in this small population, there were no significant differences between supine and upright SPECT imaging for diagnosing CAD, identifying individual stenoses, or identifying defect reversibility.

1010-67 Effect of Subcutaneous Implantable Cardiac Defibrillator Patches on Tl-201 Myocardial Imaging

Neshe E. North, Robert W. Nance Jr, Jeffrey S. Stevens, Blair D. Halperin, Richard A. Wilson. *Oregon Health Sciences University, Portland, OR*

Subcutaneous patches are frequently used with nonthoracotomy implantable cardiac defibrillator (ICD) devices. The effect of these patches on thallium imaging for the evaluation of myocardial ischemia is unknown. This study evaluated the attenuation effects of two commercially available subcutaneous ICD patches on Tl-201 myocardial tomograms. *Methods:* Two sets of post-reinjection Tl-201 tomograms, with and without ICD patches